

ON COLLECTING AND PREPARING FLESHY FUNGI FOR THE HERBARIUM.¹

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(WITH PLATE XIV)

OUR North American flora is so rich and its territory so large, in comparison with the number of botanists engaged in its study, that the knowledge of even the distribution of some large classes of its plants is very inadequate, being based chiefly on work covering comparatively limited regions. This is especially true for the fleshy fungi (Basidiomycetes and larger Ascomycetes), the larger number of which are rapidly putrescent and therefore not usually found in the collections of professional botanical collectors and explorers, to whom we owe so much in other classes. The larger herbaria and exsiccati are also, for the most part, comparatively poor in their representation of our fleshy fungi, exclusive of the more persistent Polyporeæ, Hydneæ, and Thelephoreæ. My personal observation leads me to believe, however, that there is no class of plants concerning which people who are not botanists would more gladly have a botanist's knowledge than of the class Basidiomycetes, and there is probably no class of plants whose collection and study in one's home locality can be carried on with greater interest for a series of years, provided one has sufficient freedom during the summer and autumn months to make collections when the weather conditions make these plants most abundant, to take full notes at the time of collecting and while the plants continue fresh, and, finally, to prepare and preserve his plants so that they may serve as a nucleus for comparison and study in following years. It is the aim of the present paper to point out

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practical methods of doing this work so that it may afford results and collections of permanent scientific value.²

COLLECTING.—For collecting fleshy fungi, I have seen nothing better than a common splint basket with hinged cover (*fig. 1*), such a basket as is often used for a lunch basket at picnics or as a workman's dinner basket, and is to be obtained for twenty to thirty cents. My preference is for a size about $14^{\text{in}} \times 9^{\text{in}} \times 11^{\text{in}}$ deep. Such a basket is much lighter than a tin box; it is provided with a pair of handles by which it may be carried suspended from the arm; the cover protects the contents from injury by direct sunlight and, in going through woods and thickets, from injury by branches. The convex cover is thrown back while one stops to make a collection and it forms a receptacle 3^{in} deep, very convenient for the temporary arrangement of the material. Fleshy fungi find too close an atmosphere in a tin collecting box and rot down much sooner than in the basket.

It is well to carry in the basket a chisel for the removal of species growing on wood, and a trowel-like knife for those growing deep in the ground or for those which it is desirable to carry home in the original clusters. One or two small tin or pasteboard boxes should also be provided to hold the more delicate and fragile species. The basket should contain a package of thin, but strong and tough, uncolored paper—a heavy weight tissue paper which does not become too tender when moist is good. This paper should be cut into squares and rectangles varying in size from 6^{in} square to $1^{\text{ft}} \times 2^{\text{ft}}$.

Whenever a species that is to be saved is found, it should be collected, if possible, in sufficient quantity for several ample specimens, pains being taken to obtain a full series of stages, both young and mature, and to take up each plant with as little injury as possible in order to show the base of the stem and any sclerotoid or radicated parts present. A sheet of paper large enough for the collection is then selected from the package and spread out in the open cover of the basket. The plants are

²Cf. Humphrey: The preparation of agarics for the herbarium. BOT. GAZ. 12:271. 1887.

arranged on the central portion of the paper so as to form a compact pile, and in this pile is placed a slip bearing the written field notes of this collection. The four corners of the sheet of tissue paper are raised and brought together above the pile and twisted together so as to draw the sheet closely about the pile of fungi and hold the plants firmly, forming a compact package in which the individual plants cannot be shaken about. These packets should be bedded closely together in the basket so that they may be carried without shaking. Very heavy specimens weighing several pounds each should be placed at the bottom of the basket preferably, or resting one on the other at one of its ends.

The fleshy fungi are very fragile, yet I have made many collecting trips in the rugged Green mountains, collecting in rough wooded places through the greater part of the day, and driving towards its close from five to twelve miles with my basket of specimens, or oftener carrying the basket knapsack-fashion on my back while riding a bicycle, and yet have found the plants in perfect condition in the packages when home was reached. During the annual field-day of our Botanical Club last September, Professor Jones and I collected fleshy fungi on the ascent up the west side and on the summit of Mt. Mansfield during the first day, and on the second day down the steep eastern slope through the forest to Smugglers Notch and through the Notch. Then there was a rapid ride over a rough road to Jeffersonville and a further ride of several hours by rail home. Our collections came through in fine condition, however, and gave a large number of interesting species a place on the state list. The paper wrapper about each package gives rigidity and elasticity to the contents of the basket, retains the original moisture of the plants well, and does not wholly prevent the circulation of air through the basket. If decay begins in any package, it is confined there. In addition to this, the great advantage of having each species with its field notes kept by itself, will be appreciated by every one whose work has been with the lower cryptogams.

FIELD NOTES.—Field notes are of great importance³; they should always be made for each species which one does not already know well, and also for any collection which impresses one, although in a vague way, perhaps, as strange or unusual. Such notes afford in many cases decisive characters in the determination of the species. Some characters are so evanescent that they cannot be made out after the plants have been kept a few hours; if there is to be any doubt about any such character, that doubt can usually be settled by five minutes search for a good plant much more satisfactorily and more easily than by perhaps hours of hard work in the consideration of technical descriptions.

In general, notes treat of viscidness, hygrophaneity, and field-dryness of the pileus; of the colors of the lamellae, if they differ in color in young and mature plants; of the presence of milk and its color and taste; of noteworthy characters of the stem, as viscidness, the presence of a cortina and its color in young plants, and of an evanescent ring or volva; and of the special habitat of species growing on wood, under pines, in swamps, open pastures, etc. These notes are quickly made, as positive characters are the only ones usually stated, although in some cases specific statement of the absence of distinctive characters is very helpful. The field notes should be placed at once in the package with the plants to which they refer.

CARE OF PLANTS PREPARATORY TO IDENTIFICATION.—As soon as possible after reaching home or the place where the further work of determination and drying is to be done, the packages of fungi should be removed from the collecting basket and distributed in other covered baskets so that the packages may stand closely together on the bottom of the basket but not usually resting one on the other. In this distribution, the packages containing the most putrescent fungi, such as species of *Coprinus*, *Psathyrella*, *Panaeolus*, *Boletus*, *Flammula*, *Tricholoma*, *Hygrophorus*, and *Amanita*, may with advantage be

³Cf. Underwood: Suggestions to collectors of fleshy fungi. Alabama Agr. Exp. Sta. Bulletin 80:271. 1897.

placed in a basket by themselves, as they should be the first identified and dried, or many will be lost by decay. The packages of less putrescent fleshy fungi may be kept fresh in fair condition for two or three days after being collected, but the difficulty in their study and determination increases with the time they are kept.

COLLECTING THE SPORES.—While distributing the packages from the collecting basket, at least one plant in each package should be set for spores, which may be collected very easily and without the sacrifice of a plant. Sheets of white paper and of black paper without a glossy surface are needed. If there is reason for believing that the plant bears white spores, a circular disk of the diameter of the pileus is cut with scissors from the black paper; this disk is then slit radially from the margin to the center, and enough of the paper is cut away about the center to give an opening of the diameter of the stem just underneath the pileus. The paper disk is then placed underneath the pileus in contact with it and with the stem passing through the opening made for it. The plant is then placed in erect position in the pile from which it was taken, and the other plants of the pile are arranged about this plant in such manner as to support it in erect position and also to hold the paper disk close up against the pileus. The four corners of the wrapping sheet are then brought together above the pile of plants and twisted together in the manner already described. The package of plants is then placed in the proper basket.

If the fungus is believed to have colored spores, the disk is cut from white paper. When the color of the lamellae causes doubt as to the color of the spores, set one plant for white spores and another for colored spores. In the case of species of *Clavaria* (exact knowledge of the color of the spores is necessary for specific determination in this genus) and of sessile and lateral stemmed pilei, it is merely necessary to lay one or more plants hymenial side downward on the spore paper in the pile and to enfold all again with the wrapper. The white paper may be obtained gummed and the spores will become imbedded in the

adhesive matter, giving a spore print from which the spores will not be rubbed away.

More elaborate methods of collecting spores have been proposed.⁴ The above simple method has been found to work well and to require but a small amount of labor and no bell-glasses to protect from currents of air. It has also the great advantage of keeping all the plants of a collection together.

DETERMINATION OF THE SPECIES.— In this connection, a statement which I made at our meeting of last year may be repeated: "When material is plenty, it is not usually worth while to determine for the first time dried specimens of the fleshy fungi. After one knows a species and has it in his herbarium, it is not difficult to recognize the species in dried specimens; but first determinations of fleshy Basidiomycetes and Ascomycetes are best made on fresh plants." During the night spores will fall on the paper disks in sufficient quantity to show their distinctive color. On the second day, therefore, one should proceed with the study and determination of as many as possible of his collections, and he can do so with the assurance that the unbiased observations made and the positive knowledge thus far gained will materially lessen the labor of his further study and contribute to the accuracy of his final determinations.

Many of the collections will be traced through to their species with but little trouble — this is especially true for the better known species of world wide distribution or of economic importance — and one will feel sure of the correctness of his determination. For such cases it is perhaps only necessary to add in addition to the usual data of specific name, date, locality, and details of local environment or habitat, a concise statement of the characters by which the plant is referred to the particular species, of the flesh and its color, taste, odor, and change of color when wounded, and of the characters already noted in the field notes. If the plants have been found to agree with a reliable plate of the species, record should also be made of the plate. In most

⁴HARZ in *Botanisches Centralblatt* — :78. 1889. Translated in *Jour. of Mycology* 5:163. 1889.

cases these data may be given in the regular herbarium label, but in some instances it may seem best to use a larger slip.

Difficulty will be experienced in determining some of the collections, or some collections may be referred to rare or little known species. In all such cases full descriptive notes should be made of all characters of the plants. These notes should treat of the pileus with regard to form, surface, moisture, color, hardness, and size; of the lamellae, tubes, or other hymenial surface with regard to relation to the stem, relative distance apart, connection with each other, waxy surface, surface studded with drops, color, form, and breadth; of the spores with regard to color, surface, form, and dimensions; of the stem with regard to structure, surface, coloration external and internal, form, dimensions, base, presence of a volva, ring or cortina, and its color and persistency; of the flesh with regard to color, taste, odor; of any change of color which any part may show on being cut or bruised; of the presence of milk and its taste and color; of the mode of growth of the plants, whether solitary, gregarious, or cespitose; of the kind of soil in which they grew or on what kind of wood, or other substance, and whether in woods and their kind, or in open fields; and also of locality and date; and of any other matter of which record seems desirable.

A suggestive outline for these full notes is afforded by the blank for collectors' notes in use by the members of the Boston Mycological Club. This blank also affords great help to the beginner by giving the usual scientific terms in which descriptions are couched.

An earnest attempt should be made to determine each species of which one makes an ample collection. From an ample collection one is not likely to conclude that an individual variation or abnormality is a constant character of the species. If the attempt at determination fails for the time being, the dried plants accompanied by full descriptive notes will usually make identification possible later on. Species not readily determined at the time often prove the prizes of the trip.

DRYING.—Well dried plants in ample amount, carefully pre-

pared for the herbarium and accompanied by accurate notes of the characters of the fresh plants generally afford the most satisfactory specimens for the herbarium. If such specimens can be supplemented by photographs, sketches, drawings in color, sectional preparations, or specimens in alcohol, so much the better. In a few genera and one family, the Tremellineae, which dry poorly, alcoholic specimens are to be preferred, but in general well dried plants properly prepared are very satisfactory; they are convenient for reference also and do not occupy too much space.

A good herbarium specimen of a basidiomycete should show not only its external form, surface and habit but also its internal structure. Some plants should therefore be split lengthways into halves with a sharp knife or scalpel. If skillfully prepared one of these halves will show the thickness of the pileus, breadth of the lamellae, relation of the lamellae to the stem, structure of the stem, and sometimes the color of the flesh. Earth adhering to the base of the stem should be carefully removed, pains being taken to leave uninjured the whole base of the stem with its volva and radicated portions, when these are present.

The primitive mode of drying fleshy fungi is by the heat of the sun. This method gives good results with a few genera, but it is not available during the night and on cloudy days. At its best, it is so slow that thick, fleshy species of such a genus as *Boletus* become so decayed and so eaten by larvæ that the stem usually separates from the pileus and the tube characters become almost lost.

A better method is to place the fungi in a wire basket and suspend this above a stove. This gives good specimens if the heat is maintained night and day. During the summer the kitchen range is likely to be the only stove in which a fire is kept going. Now, many of the fleshy fungi which one will dry contain insect larvæ; as the plants dry out these larvæ literally drop from the frying pan to the fire. It is evident that the mycologist may encounter serious domestic obstacles in his attempts to use the range.

For some time I have been using a preferable method which I devised during my student days in order to save my collections. My Vermont collections of the last two seasons have been dried in a galvanized wire tray $14 \times 20 \times 2^{\text{in}}$ deep (*fig. 2*). This tray is suspended horizontally 16^{in} above the floor against the side wall of a room by strong cords tied to the four corners of the tray and passing over a nail higher up in the side wall. As soon as a species has been determined, its characters noted, and the plants prepared as already directed, it is placed in a pile by itself, with its label, on the wire tray in the most favorable place available. An ordinary kerosene hand-lamp, total height 11^{in} , is placed under this pile of fungi of one species, or more usually under several piles grouped side by side, if several species are drying at the same time. The flame of the lamp is adjusted so that the current of heated air which rises up through the plants will not be hot enough to bake them. Species not subject to the work of larvæ, and which would make fine specimens by slow drying by sun heat, may be placed at places on the tray not directly above the lamp. As the piles of plants accumulate on the tray, more lamps are lighted and placed beneath it. Three lamps are sufficient for a tray of the area of mine. The lamps are kept going night and day until all plants on the tray are thoroughly dried.

During the process of drying the brittle stems of many species become pliant for a time. While in this condition it is a good plan to bend them near the point of attachment to the pileus so that they may lie in nearly the same planes as the pilei. Most species dry out rapidly in a few hours; others, as large Boleti and Lactarii, may require twenty-four hours, and may require turning once or more. As rapidly as plants are thoroughly dried in any piles, I remove such plants from the drying tray and place them, each species by itself, on the thick sheets of felt paper which are used as "driers" for flowering plants. During the busy collecting season my plants lie in the piles on these driers, from half a dozen to twenty ^{species} to a drier, in a room where they will not be disturbed. They may

be stored temporarily in paper bags or boxes, one species collection to a bag or box, and with each is kept its label, notes, and spore print.

PREPARING THE ROUGH-DRIED PLANTS FOR THE HERBARIUM.— During the process of drying, many fungi bend and curl into very unnatural and irregular shapes. In their rough dried condition they cannot be distributed in the sheets of an herbarium. They have first to be moistened and then flattened and kept in that condition until they are dry again. This part of the work may be done at one's convenience.

I moisten the plants by placing them in a moist chamber, leaving them there until sufficient moisture has been absorbed so that they can be bent without breaking. I use for this purpose a dry goods case made of matched boards. The inside dimensions of the case are $27 \times 20 \times 16^{\text{in}}$ deep. It is large enough so that two dryers with their loads of dried fungi may be placed side by side in the bottom. Cloths dipped in water and wrung out so as not to drip, are hung in a curtain-like manner inside the case against the side walls. Another wet cloth is spread across the open top of the box and the board cover is placed over this. Most of the smaller species absorb sufficient moisture in two or three hours, but large species of *Boletus*, *Lactarius*, and *Russula* may need to be left in the moist chamber over night or even longer. A damp cellar will serve the purpose of a moist box.

In the pliant condition the stem and pileus may be bent by the fingers so that both lie in the same plane, and the pileus may be given a more natural form than it assumed in drying. Care must be exercised to do no violence to any part, nor to separate the lamellæ from the stem. When shaped for the herbarium, the plants must be prevented from curling in drying. This is accomplished by placing them in folded sheets of unsized paper between driers, placing these in a pile with the least weight on the pile sufficient to prevent curling. This is not *pressing* the plants, as that term is used with reference to flowering plants; it is simply preventing their curling out of shape

while parting with the absorbed moisture. Pressure would crowd the lamellæ close together and crush them against the pileus, obliterating one of the most distinctive features of the fungus. In a well prepared specimen, unless the lamellæ are very broad, one should be able to look between them to the under surface of the pileus and make out venose connections if present.

If the plants are to be poisoned with a solution of corrosive sublimate or of strychnin, the poisoning should be done just before placing the specimens between the driers.

MOUNTING.—They will be dry enough for mounting after they have lain two or three days between the driers. Species sheets of standard size will be found preferable to half sheets for an herbarium of fleshy fungi. If the collection is small, it may be placed in an envelope of the Gray Herbarium style, and the envelope, bearing its label, should be glued to a card of somewhat larger size near its lower end (*fig. 4*, lower right hand corner). Sheets of mounting paper may be cut into halves, quarters, eighths, etc., for the cards. If the specimen is not scanty, two typical plants should be glued to the upper part of the card, one showing the upper surface of the plant and the other its under surface. These plants outside the packet facilitate comparison when referring to the herbarium, and they also catch the eye as one turns the sheets, and help to keep the species well remembered (see *fig. 4*, upper left hand corner).

The small card bearing the collection, part on the card and the remainder loose in the envelope, should be pinned to the species sheet at some place which will aid in keeping flat the pile of sheets of the genus. The several collections or specimens of the same species may be advantageously pinned to the same species sheet. If the collection is very large, a large envelope of the style used by Ellis in *N. A. Fungi* and *Fungi Columbiani* will hold the specimens from falling out better than the Gray Herbarium kind.

By this method the whole collection is kept together as a specimen in the herbarium. A specimen is not likely to be too ample. If some plants can be spared from it for exchanges,

they may be conveniently kept in the original collection until they are needed by others, and in the meantime they do not detract from its value for consultation. This does away with unmounted duplicates except in the case of large, woody Polyporeæ and Hydneæ.

Bulky specimens of Polyporeæ and Hydneæ and also collections of puffballs, etc., may be stored, each species or collection by itself, in small boxes of suitable size and the small boxes in larger boxes having the length and the breadth of a genus cover and a depth of $1\frac{1}{4}$, $2\frac{1}{2}$, or a greater number of inches. These boxes are a great convenience. They may be kept in the regular pigeon-holes of herbarium cases, distributed among the families of which they contain specimens. In case of a specimen to be looked for in one of these boxes, a reference to the box in which it is kept should be given on the regular species sheet where one looks first.

SECTIONS OF FLESHY FUNGI.—In general, sectional preparations are regarded as of secondary value as compared with well dried and carefully prepared plants accompanied by good notes, but when well made and given in addition to the dried plants and notes, they add greatly to the value of the specimen. A full set of sectional preparations includes a median longitudinal section through a mature plant, the outer layer of the stem for the whole length of the latter but for only one-third of its circumference, the outer layer on the upper side of the pileus, and a spore print. If the plants are cespitose in growth, several median sections of different plants of a cluster will be grouped together. Median sections of young plants will also be needed in some cases to show inrolled margin of the young pileus, attachment of the veil, etc. The median longitudinal section of a mature plant is usually the most important preparation of the set. It must show faithfully the structure of the stem, the degree of attachment of the lamellæ or tubes to the stem, the breadth of the lamellæ or tubes, the thickness of the pileus, and the outline of the plant. No carelessness or inaccuracy in any respect, as, for example, omission of the stuffing of the

stem, can be tolerated, as it makes the preparation directly misleading.

A thin-bladed knife or scalpel with a keen edge is used for cutting these sections, which must be cut very thin. The sections, as cut from the fresh plants, are arranged as naturally and artistically as possible on the gummed side of a rectangular piece of gummed paper just large enough for them. A piece of waxed paper such as florists and confectioners use is laid over the sections and it must also cover all the exposed gummed surface of the gummed paper. The combination of gummed sheet, sections and waxed paper is placed between sheets of light weight blotting paper and driers in a plant press and dried rapidly under heavy pressure. The sections adhere to the gummed sheet, retain their colors better than by any other method with which I am familiar, and do not shrink much in drying. When they are quite dry, the waxed paper may be lifted from the preparations and the gummed sheet. I glue the back of the gummed paper at the corners against the upper part of the card bearing the envelope of dried plants of the same collection, as shown in *fig. 4*, with the collection at the right hand corner of the species sheet.

Herpell⁵ has given full directions in regard to preparing sections of fungi and he has also issued a fine set of such preparations.

PRESERVATION OF FLESHY FUNGI IN THE HERBARIUM.—The dried fungi may be poisoned with dilute solutions of corrosive sublimate or of strychnin by the methods in use for flowering plants. In Rep. N. Y. Mus. 24: 43. 1869, Mr. Peck gave the formula for a solution of corrosive sublimate, sulfuric ether, turpentine and alcohol which he was then using on the specimens in the N. Y. State Herbarium. This solution has not worked well in use, and in its stead Mr. Peck kindly permits me to give his formula for a strychnin preparation which he is now using and finds more satisfactory in all respects.

⁵ Präpariren u. Einlegen der Hutpilze für das Herbarium. Berlin. 1880; Sammlung präparirter Hutpilze. St. Goar. 1881-1884.

Strychnin poison mixture :

Sulfate of strychnia.	$\frac{1}{8}$ oz.
Warm water.....	4 or 5 oz.
Alcohol.....	about 2 oz.

Dissolve the strychnin in the warm water; add alcohol to the solution until the mixture becomes thin enough to spread easily and to penetrate the specimens. The simple aqueous solution is not absorbed readily or spread easily, manifesting a tendency to gather in globules like mercury. The addition of the alcohol overcomes this difficulty.

A thorough application of the poison should be made with a soft brush to every portion of the surface of each plant. The application can be made with the least labor when the moistened plants, after being shaped for the herbarium, are about to be placed between the driers. As the poison does not penetrate to any great depth, "moth balls" (naphthaline, camphorine, etc.) are often placed in the boxes with specimens of very thick and bulky fungi, such as species of *Fomes* and the like, to keep away insect visitors.

My herbarium of fleshy fungi is stored in insect proof tin boxes. These boxes (*fig. 3*) are large enough to take genus covers and mounting sheets of the full standard size; they are 6ⁱⁿ high—larger than the usual herbarium pigeonhole, but this is an advantage as some genera are very bulky. These tin boxes have a well made drop door at the front end, which fits so well as to retain vapors of carbon bisulphide in the box for fully forty-eight hours. The boxes are kept in a herbarium case.

When my herbarium was transferred to these boxes, a small saucer containing about 5^{cc} of carbon bisulphide was placed in each on the pile of plants it contained. At the end of three days the saucers were removed. There has been no evidence of further insect work in the contents of these boxes. Since that time all the collections of the season and all specimens received by exchange are subjected to the vapors of carbon bisulphide for at least forty-eight hours before being distributed in the herbarium. I find the chief drawback to this method of storing a herbarium of fleshy fungi to be the great expense of the tin boxes, of which I now have forty-two in use. To make

space for future additions, I think of poisoning a portion of the herbarium, consisting of groups of genera least troubled by insects, and keeping this portion in the ordinary herbarium pigeon-holes.

MIDDLEBURY COLLEGE, MIDDLEBURY, VT.

EXPLANATION OF PLATE XIV.

FIG. 1. Collecting basket.

FIG. 2. Drying tray of galvanized wire of $\frac{1}{4}$ in mesh.

FIG. 3. Insect-proof tin box for storing the mounted fungi. This is intended to take the place of the pigeon-hole in an herbarium case.

FIG. 4. Sketch of a species sheet of *Lactarius trivialis* Fr. var. *gracilis* Pk. from my herbarium, showing four collections each mounted on a card and the cards pinned to the sheet. The plants of each collection are loose in their respective packets, with the exception of that at the upper left hand corner of the sheet where one plant has been mounted outside the packet on the upper part of the card, and with the exception of the collection at the lower right hand corner where a set of sectional preparations on gummed paper is mounted on the upper part of the card.